

Research on the Environmental Performance Evaluation System for Power Enterprises Based on the DSR Model: A Case Study of Power Company J

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Abstract. With the rapid development of the economy and society, pollutant emissions from heavily polluting industries such as the power sector have caused significant damage to the atmospheric environment, leading to increasingly severe environmental challenges. In this context, China has actively responded to international calls and introduced policies related to the "dual-carbon" goals. Currently, research on environmental performance auditing in the power industry remains relatively limited, and a standardized model for environmental performance auditing and evaluation has yet to be established. To address this gap, this study innovatively explores the construction of an environmental performance auditing and evaluation system for the power sector and applies this system to a specific case enterprise. Furthermore, targeted recommendations for optimization are proposed from multiple perspectives, including enterprises, government agencies, and third-party auditing institutions. The aim is to promote collaborative efforts among relevant stakeholders, explore the establishment of a unified industry-wide environmental performance auditing and evaluation system, and support the deepening of practical environmental performance auditing work, thereby demonstrating significant practical value and innovative significance.

Keywords: environmental performance, evaluation system, environmental management.

1. Introduction

In September 2020, China first proposed the "dual-carbon" strategic vision at the 75th United Nations General Assembly, setting clear development objectives to achieve peak carbon emissions by 2030 and carbon neutrality by 2060. In recent years, the National Audit Office has gradually carried out environmental performance auditing practices for some major environmental projects. However, research focusing on environmental performance auditing for heavily polluting enterprises, particularly in specific industries, remains largely confined to theoretical discussions and lacks a mature practical application framework.

As a core industry of coal consumption in the energy sector, the power industry emits substantial pollutants such as sulfur dioxide, nitrogen oxides, and dust during production, making it a major source of atmospheric pollution. A prerequisite for precisely managing such pollution is a comprehensive understanding of the actual emission status of power enterprises. Therefore, constructing a scientifically appropriate environmental performance auditing and evaluation system is particularly essential.

Building on a systematic review of domestic and international research literature related to environmental performance auditing and evaluation, this study conducts an in-depth analysis of the current status and challenges of environmental performance auditing in the heavily polluting power industry. A specialized evaluation index system is developed based on the DSR (Driving Force-State-Response) model to provide a practical tool for environmental performance auditing in power enterprises. Based on the application results of this system, key issues in the environmental performance management of power enterprises are identified, and targeted optimization recommendations are formulated. The study aims to offer practical reference and theoretical support for the future establishment of a unified environmental performance auditing and evaluation system within the industry.

2. Problems in the Environmental Performance Auditing and Evaluation of Power Industry Enterprises

2.1. Deficiencies in the Environmental Accounting System

The power industry lacks targeted laws and regulations mandating enterprises to establish a comprehensive environmental accounting system. Meanwhile, enterprises themselves show insufficient initiative in voluntarily implementing environmental accounting, primarily due to cost-control considerations. Consequently, when constructing an environmental performance auditing and evaluation system, it becomes difficult to effectively obtain the foundational data required for some core indicators.

2.2. Narrow Participation Structure in Auditing and Evaluation

The current environmental performance auditing work is predominantly led by the National Audit Office and implemented by local audit authorities, remaining largely in a phase of practical exploration. The participation of social auditing institutions is relatively low. This situation presents two major issues. First, government-led environmental performance audits tend to focus heavily on reviewing the fund flows and financial compliance of large-scale environmental protection projects. This approach often fails to adequately address deeper issues such as the effectiveness of policy implementation and overlooks the critical fact that waste generated during enterprise production is a primary source of pollution. The coverage of audit subjects thus shows significant gaps, hindering the audit evaluation from fulfilling its substantive supervisory and guiding role. Second, relying solely on government audit agencies presents distinct limitations. Challenges such as an insufficient number of auditors and a mismatch between their professional expertise and the interdisciplinary demands of such audits constrain the efficient advancement of environmental performance auditing and evaluation.

2.3. Absence of Tailored Auditing and Evaluation Standards

Auditing and evaluation standards form the core basis for auditors' work. These standards primarily encompass relevant policy documents, laws and regulations, pollutant emission limits, and environmental accounting guidelines. The derivation of audit conclusions, the formulation of audit opinions, and the proposal of recommendations all rely on these standards. Compared to traditional audits, environmental performance audits require a broader scope of evaluation criteria. However, as this field is still in its nascent stage, documents and regulations issued by relevant departments such as the National Audit Office, the National Energy Administration, and the Ministry of Ecology and Environment are often too macro-level, lacking specific operational guidance that can be directly applied in audit practice. Existing government evaluation standards, for instance, confine environmental protection aspects mainly to project fund auditing. Furthermore, some budget management regulations from finance departments deviate from the actual circumstances of audited entities, making it difficult to precisely quantify related indicators. Concurrently, these standards exhibit gaps in evaluating social and environmental benefits. This makes it challenging for auditors to conduct a comprehensive and objective assessment of an audited entity's environmental management performance.

3. Construction of an Environmental Performance Auditing and Evaluation System for Power Industry Enterprises Based on the DSR Model

3.1. Methodology and Applicability of the Environmental Performance Auditing and Evaluation System

In research on constructing environmental performance auditing and evaluation systems, the PSR (Pressure-State-Response) model is the primary tool chosen by most scholars. However, this model

is more suitable for environmental performance auditing of specific regions or projects and cannot accurately reflect the actual impact of an enterprise's core economic activities on the environment.

Given this limitation, the United Nations Commission on Sustainable Development optimized and expanded the PSR model, proposing the DSR (Driving Force-State-Response) model. In essence, this model represents an enhancement of the 'pressure' dimension within the PSR framework. Its core characteristic lies in focusing on the interrelated effects of human social and economic activities, selecting and defining evaluation indicators from three dimensions: Driving Force, State, and Response. This model not only portrays the static status of environmental issues but also clearly demonstrates their ripple effects on socio-economic aspects. Consequently, it is better suited for constructing an environmental performance auditing and evaluation system for enterprises.

Specifically, Driving Force indicators encompass various factors that may lead to unsustainable social development, including patterns of human production activities, consumption behavior orientations, and technological development trends. These indicators represent the endogenous impetus driving the transformation of the economy and society towards a high-output, low-pollution, environmentally friendly development model. State indicators are used to characterize the changes in environmental conditions caused by the pressure exerted on the environment by an enterprise's production methods during its pursuit of economic growth. Real-world issues such as intensified air pollution, spreading water pollution, and excessive consumption of natural resources fall into this category. Response indicators correspond to the various measures taken by human society to restore ecological balance and improve environmental quality in the context of continuously changing environmental conditions. Examples include vigorously promoting energy conservation and emission reduction efforts, formulating and implementing targeted environmental policies, and strengthening comprehensive ecological environmental management.

3.2. Selection of Indicators for the Environmental Performance Auditing and Evaluation System

As a key heavily polluting sector targeted for rectification following the introduction of the "dual-carbon" goals, the power industry exhibits significant differences from industries such as steel and textiles in the selection of environmental performance auditing and evaluation indicators. These distinctions are primarily manifested in three aspects: pollutant types, industry regulatory requirements, and the severity of pollution.

Regarding pollutant composition, the environmental impact of the power industry is predominantly characterized by air pollution. While the steel and textile industries also generate air pollutants, their pollution profiles involve a relatively higher proportion of water pollution and noise pollution. Due to these differing pollution characteristics across industries, pollutant categories require further detailed classification, and the scope of corresponding tertiary evaluation indicators needs to be broadened accordingly.

At the level of industry standards, pollutant control regulations vary across sectors. Power plants must strictly adhere to the Emission Standard of Air Pollutants for Thermal Power Plants, steel enterprises implement the limits specified in the Emission Standard of Air Pollutants for the Iron and Steel Industry, and pollution control in textile mills is primarily based on the Discharge Standard of Water Pollutants for Dyeing and Finishing of Textile Industry. The differing emission limits and standard threshold values applicable to each industry serve as a crucial basis for indicator selection. Analyzing pollution severity, the power industry is the most polluting among the three sectors. It not only ranks first in carbon emissions but also has the most extensive environmental impact, making it a priority for green transformation and reform.

In summary, based on these three areas of industry divergence, the construction of an environmental performance auditing and evaluation indicator system must involve a comprehensive selection of metrics tailored to the specific characteristics of the power industry. This approach is essential to ensure the scientific validity and applicability of the evaluation system.

Table 1. Environmental Performance Audit Evaluation System Indicators for the Power Industry

Criterion Layer	Element Layer	Specific Indicators	Indicator Polarity
Driving Force Indicators	Enterprise Internal Management Level	Return on Total Assets	+
		Operating Revenue Ratio	+
		Energy Consumption per Unit of Output Value	+
		Total Power Generation of Units	+
		Cumulative Tax Paid	+
State Indicators	Enterprise Emission Management Level	Power Supply Standard Coal Consumption Rate	-
		Sulfur Dioxide Emission Intensity	-
		Nitrogen Oxides Emission Intensity	-
		Dust Emission Intensity	-
		Compliance with Environmental Laws and Regulations	+
Response Indicators	Enterprise Environmental Management Level	Application of Cleaner Production Technologies	+
		Year-on-Year Reduction in Power Supply Coal Consumption	+
		Sulfur Dioxide Reduction per Unit of Product	+
		Nitrogen Oxides Reduction per Unit of Product	+
		Dust Reduction per Unit of Product	+
Response Indicators	Enterprise Emission Reduction Economic Response	Funding for Environmental Technology Research, Development, and Innovation	+
		Enterprise Emission Reduction Human Resource Response	+
		Employee Engagement in Environmental Protection	+
		Number of Passed Third-Party Environmental Audits	+

3.3. Environmental Performance Auditing and Evaluation System Constructed Based on the Analytic Hierarchy Process

The Analytic Hierarchy Process (AHP) is a systematic, hierarchical analytical method that combines qualitative and quantitative approaches. The core principle of AHP involves decomposing a complex, hard-to-quantify objective into three levels: goal, criteria, and indicators. Factors at the same level are both influenced by the upper-level factors and, in turn, affect the lower-level factors. In this paper, based on the Analytic Hierarchy Process, a pairwise comparison matrix of indicators is constructed. By further processing the results, the weight scores for the three fundamental dimensional indicators and their specific sub-indicators can be derived, as shown in Table 2.

Table 2. Environmental Performance Audit Evaluation System Indicators for the Power Industry

Criterion Layer	Weight	Element Layer	Weight	Specific Indicators	Weight
Driving Force Indicators	0.1265	Enterprise Internal Management Level	1	Return on Total Assets	0.1332
				Operating Revenue Ratio	0.2947
				Energy Consumption per Unit of Output Value	0.1265
				Total Power Generation of Units	0.0732
				Cumulative Tax Paid	0.3724
State Indicators	0.4173	Enterprise Emission Management Level	0.6667	Power Supply Standard Coal Consumption Rate	0.4131
				Sulfur Dioxide Emission Intensity	0.2472
				Nitrogen Oxides Emission Intensity	0.2172
				Dust Emission Intensity	0.1225
				Compliance with Environmental Laws and Regulations	0.3333
		Enterprise Environmental Management Level	0.3333	Application of Cleaner Production Technologies	0.6667
				Year-on-Year Reduction in Power Supply Coal Consumption	0.4231
				Sulfur Dioxide Reduction per Unit of Product	0.2272
				Nitrogen Oxides Reduction per Unit of Product	0.2272
				Dust Reduction per Unit of Product	0.1225
Response Indicators	0.4173	Enterprise Emission Reduction Economic Response	0.4	Funding for Environmental Technology Research, Development, and Innovation	1
				Enterprise Emission Reduction Human Resource Response	0.1

4. Specific Evaluation of Environmental Performance Auditing for Power Company J

4.1. Company Profile of Power Company J

Power Company J was founded in 2000 and successfully listed on the Shanghai Stock Exchange in 2002, becoming the first listed power company in the capital. It is a state-owned holding enterprise. Against the backdrop of advancing the "dual-carbon" goals, Power Company J has actively developed new energy projects and expanded a series of emerging businesses, including smart micro-grids,

regional energy management, and integrated energy management, aiming to enhance its capacity for healthy development.

In pursuit of synergistic growth between economic benefits and ecological protection, Power Company J has taken the initiative to fulfill its responsibilities as a state-owned enterprise. It adheres to driving the development of energy-saving and emission-reduction technologies through innovation, increasing the proportion of renewable energy in its fossil energy mix, and reducing pollutant emissions. While the continuous promotion of green production has led to some improvements in the company's environmental management, the industry as a whole still lacks sufficient attention to environmental performance auditing. Consequently, Power Company J has not yet established a suitable environmental performance auditing and evaluation index system, nor has it carried out related environmental performance auditing internally or engaged third-party institutions for environmental supervision audits.

4.2. Specific Evaluation Using the Fuzzy Comprehensive Evaluation Method

Based on the DSR model, this study defines the fuzzy comprehensive evaluation factor set for the environmental performance auditing of Power Company J as $U = \{U_1 \text{ Driving Force}, U_2 \text{ State}, U_3 \text{ Response}\}$, which is further refined to the indicator level. Other factor sets are determined accordingly.

Drawing on environmental protection normative documents in the power industry, the comment set is defined as $V = \{\text{Excellent}, \text{Good}, \text{Fair}, \text{Poor}\}$. Through a designed questionnaire, 15 auditing professionals scored the company based on actual conditions and comparisons between Power Company J and industry benchmark values. By auditing and evaluating the environmental performance of Power Company J for the year 2021, comprehensive audit results were obtained.

Table 3. Environmental Performance Audit Evaluation Scale for J Power Enterprise

Indicator	Excellent	Good	Fair	Poor
Return on Total Assets	6	5	5	0
Operating Revenue Ratio	0	3	7	5
Energy Consumption per Unit of Output Value	0	5	8	2
Total Power Generation of Units	4	10	1	0
Cumulative Tax Paid	0	6	7	2
Power Supply Standard Coal Consumption Rate	0	2	5	8
Sulfur Dioxide Emission Intensity	0	4	5	6
Nitrogen Oxides Emission Intensity	0	3	9	3
Dust Emission Intensity	2	9	4	0
Compliance with Environmental Laws and Regulations	6	9	0	0
Application of Cleaner Production Technologies	3	7	5	0
Year-on-Year Reduction in Power Supply Coal Consumption	7	6	2	0
Sulfur Dioxide Reduction per Unit of Product	9	6	0	0
Nitrogen Oxides Reduction per Unit of Product	3	8	4	0
Dust Reduction per Unit of Product	5	8	2	0
Funding for Environmental Technology Research, Development, and Innovation	0	3	5	7
Employee Engagement in Environmental Protection	5	7	3	0
Number of Passed Third-Party Environmental Audits	0	0	7	8

Based on the questionnaires mentioned above, 15 evaluations were obtained for each indicator. A fuzzy comprehensive evaluation matrix was established according to these evaluations, and the calculation of the fuzzy vector for each indicator in the matrix is as follows: Taking the tertiary indicator "Total Asset Scale" as an example, if it received 3 "Excellent" ratings, 7 "Good" ratings, 5 "Average" ratings, and 0 "Poor" ratings, the calculation method is 6/15, 5/15, 5/15, 0/15. Retaining four decimal places, the result [0.4000, 0.3333, 0.3333, 0.0000] is obtained. The fuzzy vectors of

other indicators are calculated in the same way. Using the fuzzy vectors derived from the evaluation of the above criterion layer indicators, the final overall environmental performance evaluation of the enterprise is calculated as follows:

Table 4. Environmental Performance Audit Results of J Power Enterprise

	Indicator	Fuzzy Evaluation Vector	Fuzzy Evaluation Results
Environmental Performance Auditing and Evaluation for Power Company J	Driving Force	(0.1287, 0.4451, 0.3056, 0.1206)	Good
	State	(0.1109, 0.3351, 0.3127, 0.2413)	Good
	Response	(0.2128, 0.3205, 0.2444, 0.2222)	Good
	Overall	(0.1669, 0.3430, 0.2759, 0.2142)	Good

Based on the application of the fuzzy comprehensive evaluation method, the assessment results indicate that within the factor level, Power Company J's internal management capabilities, current status of environmental responsibility fulfillment, technological response to emission reduction, and humanistic response to emission reduction are all rated as "Good." The current status of production pollution is rated as "Fair," while the economic response to emission reduction is rated as "Poor." At the criterion level, the evaluations for Driving Force, State, and Response are all "Good," and the overall corporate evaluation is also "Good."

4.3. Audit Recommendations Based on the Environmental Performance Auditing and Evaluation System

Through the construction and application of the environmental performance auditing and evaluation system for Power Company J, insights have been gained from multiple perspectives regarding the company's current status of pollutant emissions and green energy conservation. Analysis of the conclusions reveals that Power Company J has achieved certain results in reducing pollutant emissions. However, issues persist, such as high unit coal consumption, incomplete environmental information disclosure, and a relatively late start in new energy projects. Therefore, based on the evaluation results, analysis, and practical circumstances, this paper proposes the following improvement recommendations for the company:

(1) Actively Explore the Establishment of an Environmental Performance Auditing and Evaluation System.

The Audit and Legal Risk Management Committee under Power Company J primarily reviews the efficiency and effectiveness of corporate fund usage and has not yet incorporated environmental performance aspects. The company's internal audit department should, in accordance with relevant requirements and policies from the National Audit Office, establish an internal environmental performance auditing and evaluation system. Regular audits of environmental performance should be conducted, incorporating key indicators for accounting pollutant emissions—especially carbon reduction volumes and utilization efficiency. Improvement measures should be promptly proposed based on issues identified through the audit evaluation system, thereby genuinely implementing "carbon reduction" actions.

(2) Increase the Utilization Efficiency of Clean Energy and Reduce Coal Consumption.

Power Company J faces the issue of a relatively late start in new energy projects. It should accelerate the upgrade and retrofitting of coal-fired units, vigorously develop new energy sources such as wind and solar power, and reduce dependence on coal. This approach not only mitigates the impact of coal price fluctuations on the company, enhancing profitability, but also promotes the

company's gradual transition toward a green, clean energy production model. This will help lower the power supply coal consumption rate and reduce emissions of sulfur dioxide and nitrogen oxides.

(3) Optimize the Corporate Environmental Information Monitoring System and Enhance Disclosure Capabilities.

From Power Company J's annual reports and social responsibility reports, it is evident that data for some indicators are only disclosed in certain years, with incomplete disclosure, and the indicators disclosed vary from year to year. This hinders the effective conduct of environmental performance auditing and evaluation. It is recommended that the company standardize and unify its practices in accordance with industry standards, promptly calculating and publishing data that should be accounted for. This will facilitate supervision by society and the government. For example, emissions of sulfur dioxide, nitrogen oxides, and dust should be measured and disclosed not only in kilowatt-hour (kWh) terms but also in the stipulated cubic meters. This will allow for more objective measurement against policy standards during audit evaluations. Furthermore, it will increase the company's emphasis on energy conservation and emission reduction efforts. Particular attention should be paid to improving indicators such as energy consumption, pollutant emissions, and comprehensive energy consumption. This will enable the public to more intuitively understand the environmental benefits resulting from the company's environmental investments, thereby enhancing the company's sense of responsibility and operational efficiency in environmental protection.

5. Conclusion

This study constructs an environmental performance auditing and evaluation system for enterprises in the power industry by reviewing and summarizing domestic and international research in this field. A representative case—Power Company J—was selected for application, leading to the following key conclusions:

(1) It is essential to actively develop an environmental performance auditing and evaluation system for enterprises in the power industry. In China, only some local governments have carried out environmental performance auditing and evaluation work, which has, to some extent, enriched practical experience. However, its actual implementation in power industry enterprises remains challenging. Issues such as an imperfect environmental accounting system, a narrow scope of auditing entities, insufficient comprehensive capabilities of auditors, and unclear evaluation standards all require urgent resolution. The underlying causes mainly lie in inadequate laws and regulations, the public-good nature of environmental resources, insufficient integration of theory and practice, and a lack of proactive environmental awareness.

(2) There remains substantial room for further development in the practice of environmental performance auditing and evaluation systems. This paper selects Power Company J, a state-owned enterprise in the power industry, as a case study to construct and apply an environmental performance auditing and evaluation index system. Using the Analytic Hierarchy Process (AHP), indicator weights were determined through comprehensive consideration, and the fuzzy comprehensive evaluation method was employed to score the relevant indicators. Finally, by further analyzing the audit results, the evaluation reflects both the achievements and areas needing improvement in the company's environmental management, and targeted improvement measures are proposed.

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